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# Desiccation of Woody Stems...

## *influenced by connected live tissues*

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***ABSTRACT:*** Desiccation of small woody stems to their equilibrium water content is the critical requirement when using herbicides to dry wildland fuels before a prescribed burn. In an exploratory study, the desiccation rate dropped markedly if dead stems were connected to a live root system. A possible explanation is that water absorbed by live roots is transported through xylem tissue and keeps moisture in dead stems above atmospheric equilibrium for some time.

***RETRIEVAL TERMS:*** prescribed burning; herbicide applications; stem desiccation; fuel moisture reduction; equilibrium moisture content.

***OXFORD:*** 436--431.2[--812.213+322.2+414.22--322.2].

The use of prescribed fire for removing undesirable vegetation is limited to infrequent burning periods when conditions are high enough to promote adequate combustion yet low enough to minimize escape to adjacent lands. By increasing the fuel flammability on the proposed site, the number and duration of these safe burning periods can be greatly increased.

An economical method for raising fuel flammability is by broadcasting herbicides that will kill the live component of the fuel complex. The success of this method hinges largely on the desiccation of the small woody stems to an atmospherically controlled equilibrium moisture content (EMC) at a time that corresponds to safe burning.

Herbicides broadcast on foliage will seldom kill both tops and roots of mature woody plants, but they will often kill small stems. Mass movement of water through the non-living xylem, which is relatively unaffected by herbicides,[1] may, however, continue as a result of a pressure gradient developed from root pressure[2,3] or reverse movement of water following absorption by dead foliage from a water-saturated atmosphere.[4]

In an exploratory study in the greenhouse, I found that the desiccation rate of dead stem tissues was markedly influenced by adjoining live tissues of both roots and stems.

### Method

Twelve magnolia (*Magnolia grandiflora* L.) saplings 2 to 3 meters tall, were preconditioned in the greenhouse as follows in March and April.

| | Day | Night |
|---|---|---|
| Light | Sunlight | -- |
| Temperature (°C) | 27-35 | 16-18 |
| Relative humidity (pct.) | 35-55 | 65-80 |

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4

Table 1 *Water content of dead stem tissues, by treatment*

| Treatment | Days after treatment | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | | 6 | | 14 | | 55 | | 81 | | 109 | |
| | C[1] | P[2] | C | P | C | P | C | P | C | P | C | P |
| | Percent | | | | | | | | | | | |
| Plant killed, | 380 | 177 | 203 | 168 | 179 | 138 | ([3]) | - | - | 8 | 7 | 7 |
| leaves intact | 338 | 200 | 18C | 118 | - | -- | 14 | 12 | 8 | 8 | 8 | 9 |
| | | | | 80 | | 98 | 14 | 15 | 9 | 12 | .. | 8 |
| Mean | 359 | 189 | 192 | 112 | .79 | 118 | 14 | 14 | 9 | 9 | 8 | 8 |
| Plant killed | | | 94 | 129 | 94 | 103 | 12 | 12 | 11 | 7 | -- | 8 |
| leaves removed | | | 67 | 80 | 44 | 53 | 21 | 13 | | 10 | - | 9 |
| | | | 123 | 99 | 106 | 76 | 15 | 14 | 10 | 8 | | 8 |
| Mean | - | | 95 | 101 | 81 | 77 | 16 | 13 | 10 | 8 | - | 8 |
| Top killed lowest | | | 132 | 110 | 120 | 104 | | 82 | 15 | 11 | | 8 |
| whorl of branches | | | 117 | 122 | 94 | 104 | 58 | 71 | 7 | 7 | 6 | 17 |
| and roots alive | | | 99 | 104 | 107 | 105 | 39 | 83 | -- | 17 | -- | |
| Mean | | | 116 | 109 | 107 | 104 | 49 | 79 | 11 | 12 | 6 | 13 |
| Top killed roots | | | 177 | 143 | 173 | 145 | 163 | 140 | 9 | 12 | - | 8 |
| only alive | | | 140 | 113 | 175 | 123 | | 129 | 51 | 64 | - | 10 |
| | | | 185 | 137 | 146 | 154 | 131 | 139 | 10 | 9 | - | - |
| Mean | -- | - | 167 | 131 | 165 | 141 | 147 | 136 | 23 | 28 | -- | 9 |

[1] Current shoot growth

[2] Past years growth

[3] missing data result of limited number of stems for sampling.

Temperature control was maintained by a 63,000-BTU refrigeration cooling unit combined with a 112,000-BTU heating unit. The greenhouse glass was not shaded to permit maximum radiation transmission. The plants were watered to soil saturation each week throughout the experiment.

The 12 plants received these four treatments , with each treatment replicated three times:

1. All plant killed, leaves intact.
2. All plant killed, leaves removed.
3. Top killed, lowest whorl of branches and roots alive (leaves intact).
4. Top killed, roots only alive (leaves intact).

Steam was used to simulate localized chemical kill without prematurely dehydrating the stem tissue. The foliage to be treated was enclosed within a large neoprene container and steam introduced to raise the inside temperature to 80°C. for 10 minutes. Four stem samples were taken before and after treatment. The steam did not appreciably change the water content. The roots were killed by immersing the pot in a water bath (80° - 90°C.) for a minimum of 2 hours.

Branches from 0.75 cm. to 1.25 cm. in diameter were randomly sampled from each plant. Samples were taken from all plants before sun-up, separated by current shoot growth and past years' growth, and sealed in heat-resistant, polyethylene-lined polyester bags for shipment to the laboratory. Samples were then oven-dried at 105°C. for 24 hours in the unsealed polyester bags and the water content calculated as a percent of the oven-dry weight. Sampling days were limited because more frequent sampling would have severely reduced crown size (table 1).

## Results and Discussion

The water content of dead stems of plants entirely killed (treatments Nos.

1,2) reached equilibrium with the atmosphere within 55 days (fig. 1; table 1). Dead plants with leaves removed (to simulate defoliation) desiccated faster than plants with dead leaves intact. This faster evaporation may be attributed to high surface temperature of the defoliated stems as a result of increased radiation when the large leaves were removed.

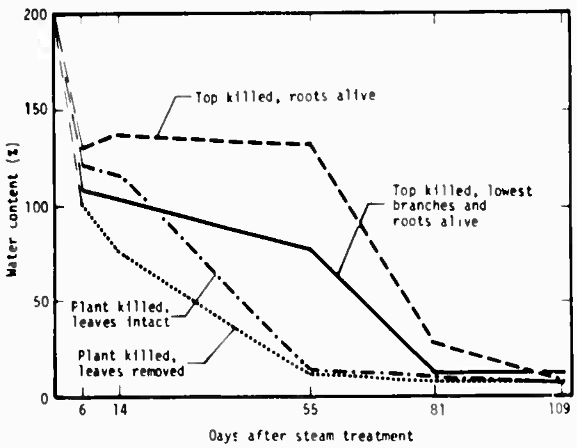


Figure 1.--*The relative desiccation of dead stem tissues.*

Dead branches above the whorl of living branches (treatment No. 3) showed a consistently lower water content than did stems on plants with only the roots alive. The difference was especially high on the fifty-fifth day (fig. 1). The apparent reduction in dead-stem water probably resulted from a higher evaporative stress developed at the live leaf surface than that at the dead stem surface. Water movement in response to this gradient would be expected to increase in the afternoon with a corresponding reduction in water content of the dead stems.

The effect of a connected live root system on water content of dead stem tissue was significant. On the fifty-fifth day, water content of past years' growth averaged 79 percent for plants with live roots under treatment No. 3, and 136 percent under treatment No. 4. In contrast, plants with dead root systems averaged 13 to 14 percent water content. Obviously, the root system functioned for several weeks to replace water evaporated from the dead tissue.

This phenomenon could be explained in two ways. A positive pressure may have been developed at night by the root system to replace water evaporated during the day. The pressure necessary to move water to the top of a 3-meter sapling would be small--on the order of 1/2 atmosphere.[5] Root pressures occur mainly in tropical environments where a continuous low soil moisture tension and a very low atmospheric stress at night combine to give optimum conditions for root pressure.[3]

The alternative explanation is that a live root system continues to absorb water which then moves into the dead tissue. This movement is in response to the tension gradient developed by evaporation at the stem surface. Since atmosphere and soil-water conditions almost always dictate this type of water movement through the plant, this explanation of the data has wide field implications.

In either case, all dead tissue reached the EMC by 109 days. This condition is probably the result of a callus layer formed at the live-dead interface that stopped water from moving into the dead stem.

A successful kill of the small stems without killing the whole plant will not necessarily lead to immediate stem desiccation. Work is now being done to determine if water movement into the dead stems results primarily from a tension gradient or from positive root pressure.

*NOTES*


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